A. Wood restoration

The original color has been preserved. The mahogany wood has been sanded up to 400 dpi. Red mahogany wood stain has been used to refresh the original color where needed. As usual, several coats of varnish have been applied to restore the original appearance. All metallic parts have been cleaned with and Autosol. In addition, sandpaper (up to 1000 dpi) and WD 40 oil have been used for very rusted screws.

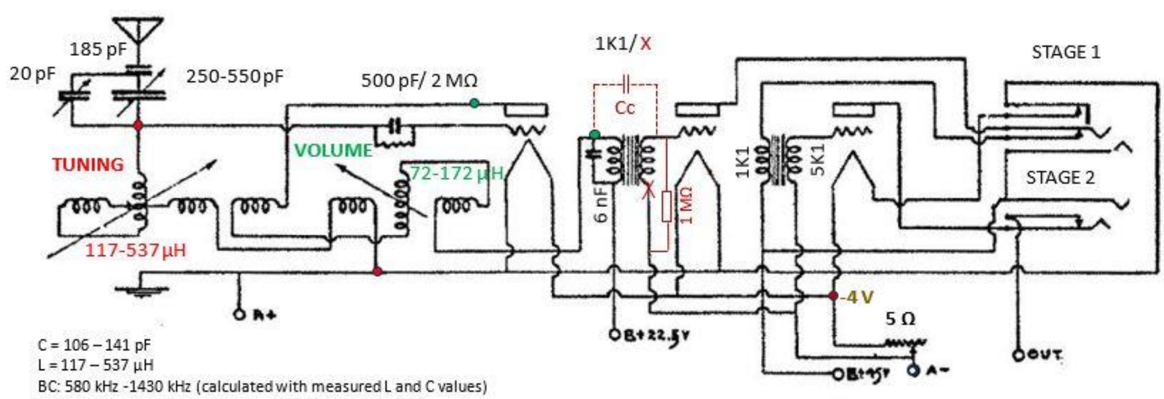
B. Electronics restoration

1. The chassis has been deeply cleaned with Autosol. The bakelite panel also cleaned and some inscription restored with white paint (water based, as for inside home painting).
2. The rheostat was completely rusted and destroyed. Probably a water damage, as suggested also by some very rusted screws. I have replaced by a 27 Ω wire bound rheostat in parallel with 2 x 22 Ω resistors (to be as close as possible to the original 5 Ω rheostat) and then I move it closer to the front panel due to different physical appearance.
3. The second AF transformer is OK, 1K1/ 5K1, a ratio usual in the time. The first one has the open secondary. The usual repair, in red at the secondary of the 1st AF transformer. The primary can be also disconnected and replaced by a 100 KΩ resistor connected from the green dot to 22.5 V DET voltage, in parallel with the 6 nF capacitor.

MODEL 5

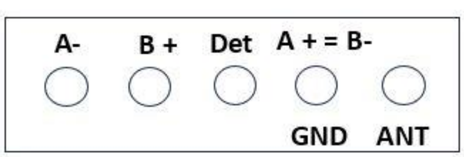
COLIN B. KENNEDY CORP.

All Tubes : 01 A



C = 106 – 141 pF
L = 117 – 537 µH
BC: 580 kHz -1430 kHz (calculated with measured L and C values)
BC: 500 kHz -1650 kHz (measured with signal generator)

Observation: VOLUME knob rotation does not change any value of the variable inductor range in TUNING



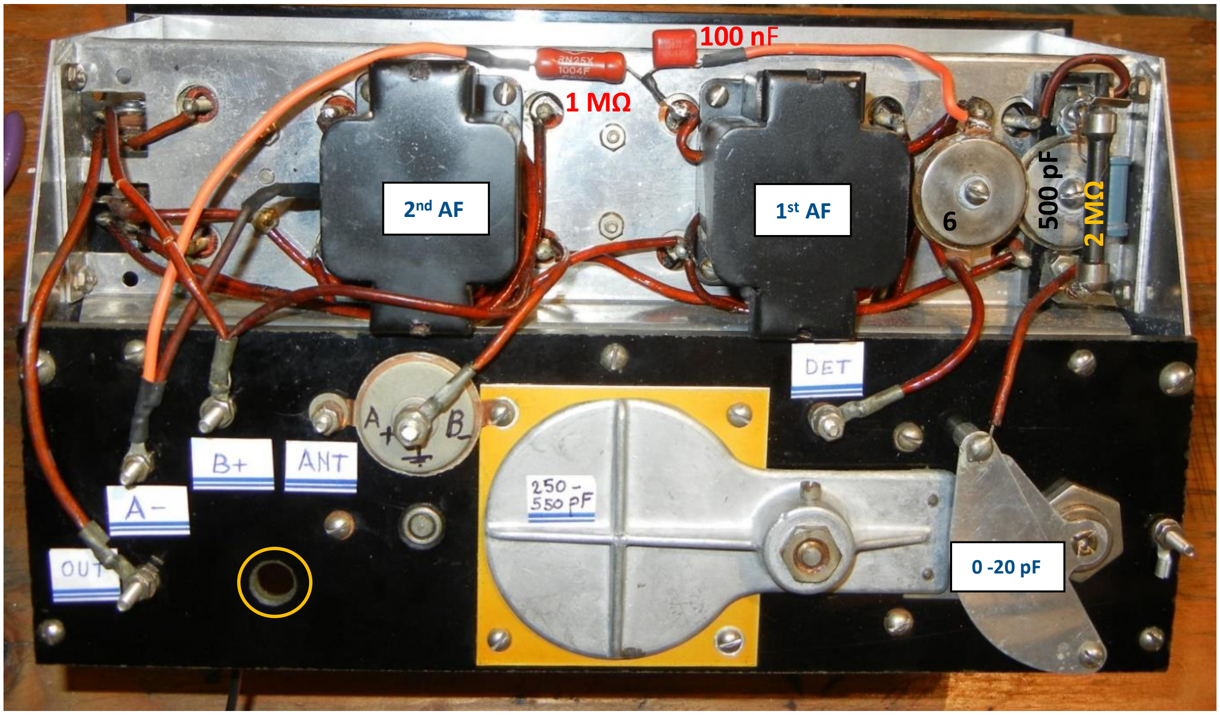
A+ = B- = GND
Det = + 22.5 V
B+ = BAT + = + 45 V

4. Inductances measurements on schematic are between red dots for tuning or green dots for volume.
5. The grid leak resistor is original. It has a sort of pump to modify the resistance. Looks like the inside is a powder and moving the agitator the resistance is varied. At the beginning was more than 10 MΩ, and by safety I connected in parallel a 2 MΩ resistor. However, after moving this agitator, the resistance drop sometimes to several hundreds of KΩ, up to 2 MΩ, the value I have connected in parallel.

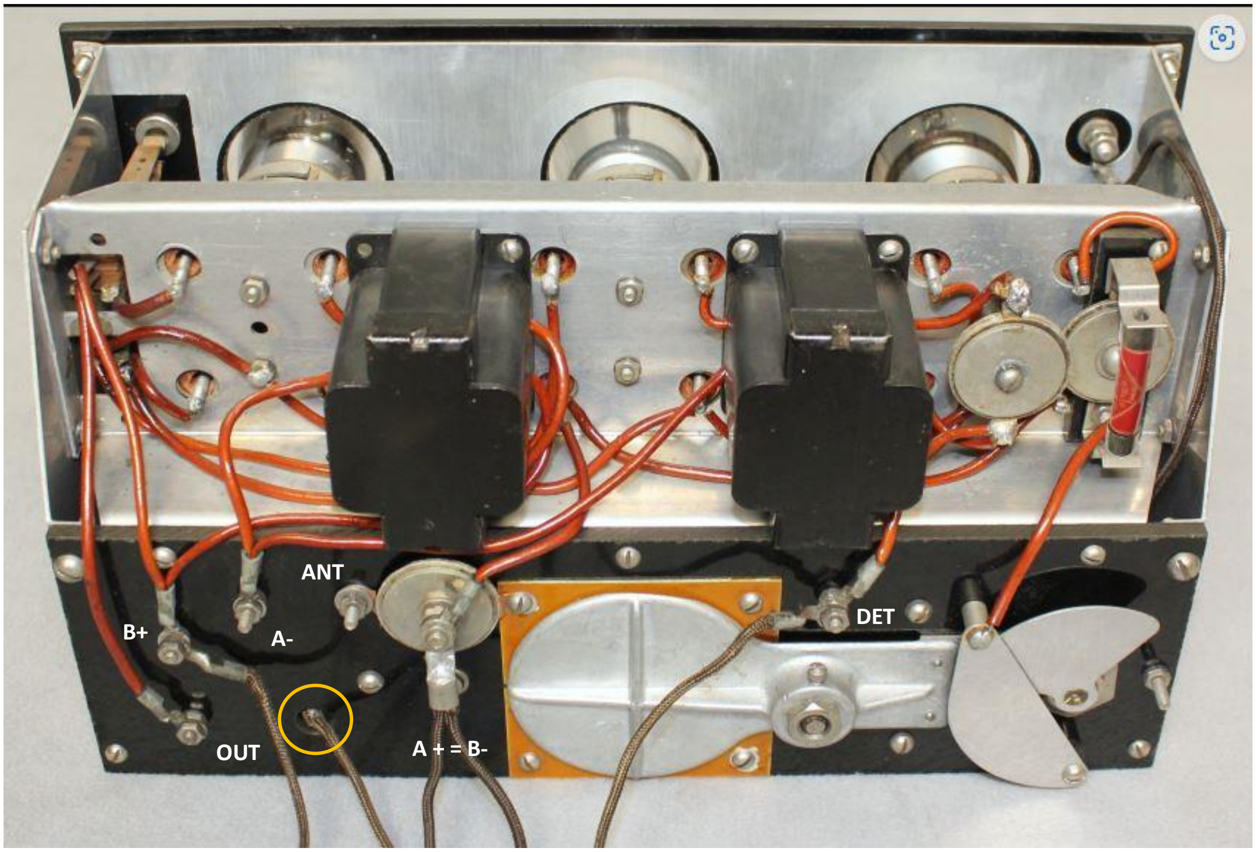
6. The middle DET connector has been added to the radio DC panel by a previous owner. I do not know why it was not in the original, because the DET voltage is used in the original schematic
7. The main variable capacitor, 250 – 550 pF, looks like a book capacitor of very high quality. It is connected in parallel with the 20-pF variable capacitor for fine tuning. In addition, the 185-pF series capacity makes the global variation of the variable capacitor between 106 pF to 141 pF (calculated and measured on the radio). This global variable capacitor in series with the variable inductance makes a tuning range from 580 kHz to 1430 kHz.
8. All wire connections to the DC panel and antenna have been identified and labelled. The orange wire is the 1st AF transformer secondary by-pass, according to above schematic. After photo was taken, it was changed in a brown wire very similar to original ones. Defective secondary section of the 1st AF transformer has been identified on the schematic with a red cross.

   Very useful information*: because the secondary is interrupted toward A-, coupling is even better without any capacitor (only the parasitic capacitance between primary and secondary, C_c in my schematic). The grid is polarised with a 1 MΩ resistor. Finally, the 100 nF capacitor has been removed. When capacitor is in place, probably the signal arrives in opposite phase as compared with the secondary transformer path. In addition, the series capacitor gives a higher response at lower audio frequencies and is not preferable when using the horn speaker. Even removing the 1 MΩ resistor the radio works in the same way, the grid of the second tube is polarised somehow with a parasitic resistance. A* ***measurement*** *was done: with the 100 nF capacitor peak to peak sinusoidal output voltage is 280 mV, without is equal to 720 mV, in the same front panel knobs configuration. This is an* ***improvement of 8.2 dB in AF gain****, just 1 dB lower than with a good 3:1 AF transformer. The radio originals are 5:1 for a theoretical gain of 14 dB.*

   To be noted that inside the macaroni tubes, the wire is a twisted multi wire stained, a very good quality. Macaroni itself, after 100 years, are very fragile, but does not affect any electrical connection. I also switched A- with B+ screws because the B- wires were a bit too short to pass easily over the screw (after taking off the rheostat from this position). Originally the A- and B+ screws were used also to maintain in place the rheostat and passes by two holes in his bakelite body. If needed the A- connector can become C- and the rheostat wire to A- can pass trough the hole (see orange circle).



9. From ***Radiola Guy*** collection, back of the chassis photo, it can be seen a wire passing trough the hole. It is probably the A- wire from the rheostat because difficult to connect inside the rheostat body where the screw is attached. In my radio, because the rheostat is now on the front panel I can connect the rheostat wire inside, directly on the screw. In addition, DET wire is connected but no connector on the back panel. Probably it was only designed for the inside B battery.



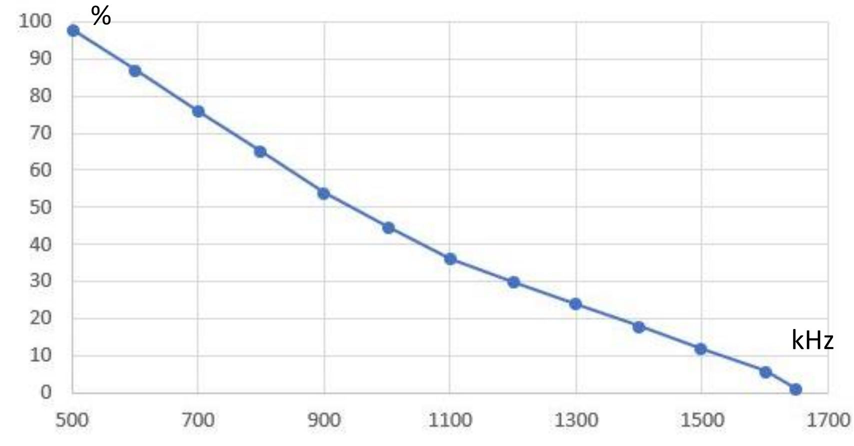
10. The ***radio does not need C battery*** because of a clever connection. The rheostat is inserted from storage A- (-6.3 V) giving an optimal voltage of -4 V on the cathode (3.3 Ω rheostat). The grids of AF tubes are optimum polarised, with negative -2.3 V from cathode. Measured ***B+ DC current = 1.6 mA***.
11. ***The radio started at the first power on*** due to carefully test of all components.
12. ***Dial indication in %*** for Montreal AM stations (10 ft. indoor antenna wire) are listed below:

name	CFQR	TSN	CKAC	CJAD	CFNV	CFMB	CPAM	CKZW
kHz	600	690	730	800	940	1280	1410	1650
%	88	79	73	65	49	25	16	3

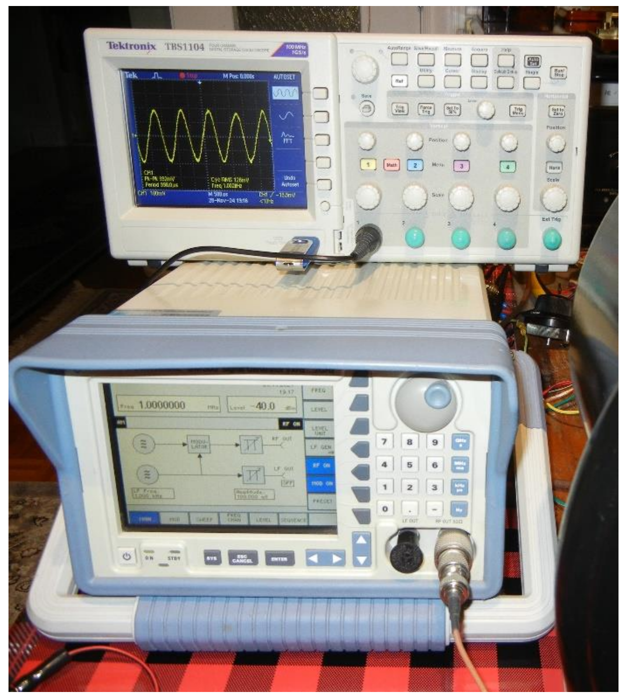
A test with the signal generator is performed. The receiver covers the **BC** from **500 kHz to 1650 kHz**. The measurements show a band a bit extended compared to raw calculation with Thompson formula without keeping in account the mutual couplings: 580 kHz to 1430 kHz.

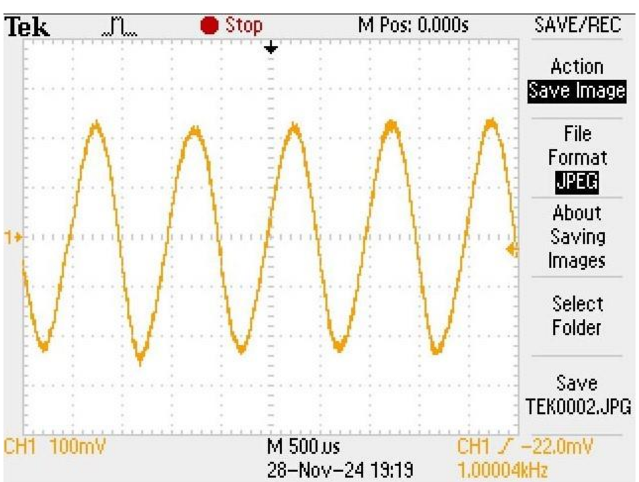
kHz	500	600	700	800	900	1000	1100
%	98	87	76	65	54	45	36
kHz	1200	1300	1400	1500	1600	1650	
%	30	24	18	12	6	1	

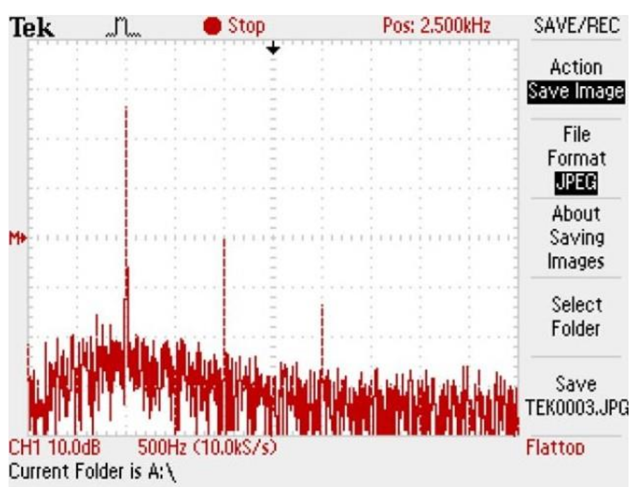
The ***tuning is quasi-linear with frequency***, a good performance. This is done to the combined tuning (inductive and capacitive) for the rotation of the dial knob. Other high-performance radios having only capacitive tuning have a non-linear variation, easy to tune at lower frequencies and more difficult at the high end. Tuning is also very easy with a single dial, rare from the time. The fine tuning helps also a lot.

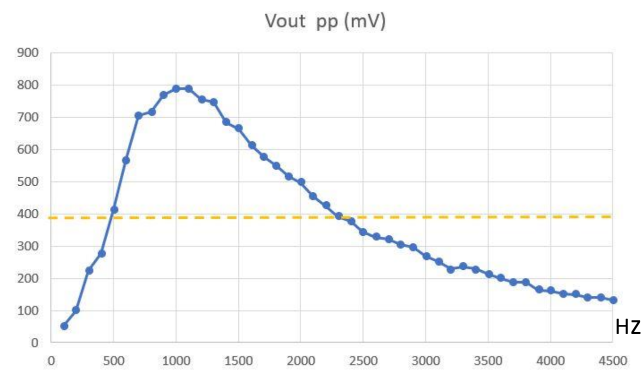


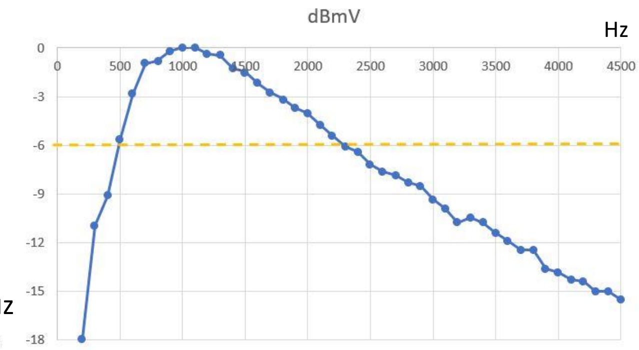
13. Test Bench includes as usual the Rohde Schwarz signal generator SM 300 and the digital oscilloscope Tektronix TBS 1104. A *Micsig DP 10013 High Voltage Differential Probe* connect the 2nd AF output (Speaker) to the oscilloscope.
    Signal generator is set at -40 dBm RF power, 1 MHz carrier, AM, modulation index 75%.
    a. ***The sensitivity*** is -40 dBm @ 500 kHz, ***-50 dBm @ 1000 kHz*** and -45 dBm @ 1500 kHz.
    b. The AF signal is captured at the 2nd stage output. Volume signal is turned below the limit of starting auto-oscillations. The recorded signal has the ***2nd harmonic at more than 25 dB below the 1 kHz tone and 3rd one at 40 dB***.
    c. AF bandwidth is also measured. As shown in Excel graph obtained with measurement points, the output voltage (peak to peak) versus frequency the ***6 dB bandwidth is from 500 Hz to 2300 Hz***, as usual for 1920's horn speakers.



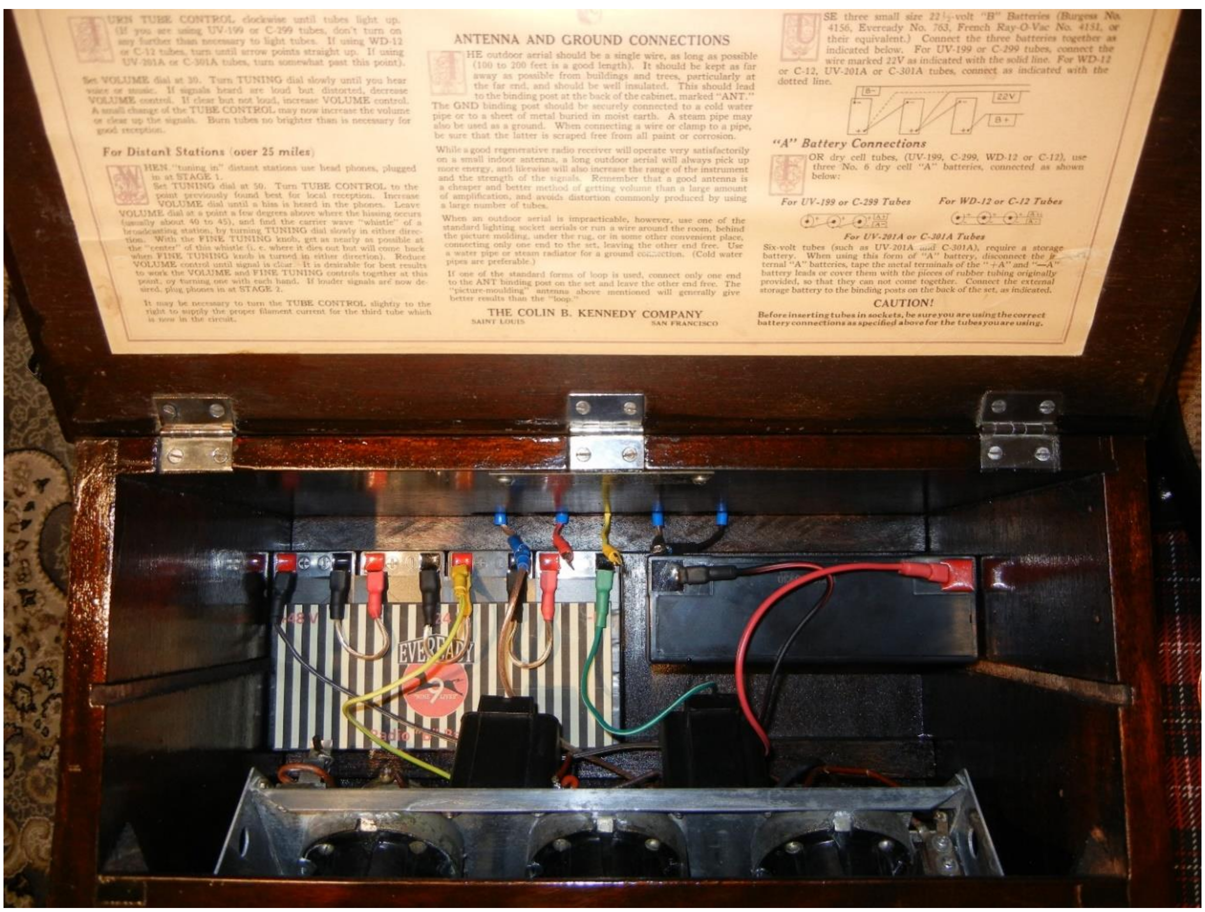






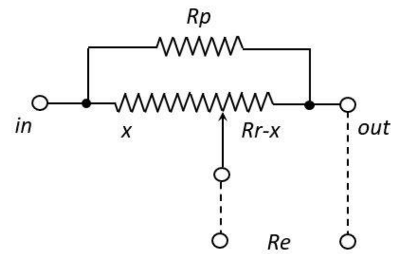


14. The receiver is also prepared for working on battery. The B battery has been configured using 4 x 12V rechargeable batteries. The A battery uses also a rechargeable 6 V battery of 12 Ah. Both can be located inside mahogany wooden case of the radio. A wooden support has been installed to keep in place both batteries.



15. A loop antenna is made behind the world map close to the radio. The inductance is around 40 µH, around 18 m of flexible isolated multiwire. A 1 nF parallel capacitor can be installed in series or parallel with the connector (resonant frequency 800 kHz). Only one end is connected to ANT input of the radio. Optimal wire length is 100 ft, about 30 m of wire on a bigger loop (about 200 µH) to be tuned with a lower value capacitance (50 – 500 pF to cover BC from 500 to 1650 kHz).

16. More comments on the rheostat replacement:
    a. The straightforward method is to add in series a resistance of around 3.4 Ω/ 3 W and a switch.
    b. Another method to replace the broken rheostat is to use two 1N4007 diodes in series with a switch. According to the diode data sheet and measurements the voltage on a diode is around 0.9 V at around 0.75 A direct current (maximum is 1 A for 1N400x diode series). Therefore, on the cathode the voltage is around 6.3 V – 1.8 V = 4.5 V, a safe and close to optimal cathode voltage for the 201A tubes (from 3.8 V to 4.3 V) as tested with this regenerative radio.
    c. If the 1920's rheostat value than can be find on the market it's not the suitable one (max 10 Ω), a parallel resistor can be used with the price to lose the linearity of equivalent resistance value versus the tuning angle ϕ. It is important to pay attention to keep the on/off function on the rheostat, therefore the parallel resistor must be added in parallel with the input/ output of the rheostat wire.
    Therefore, the equivalent resistance value *Re* function of original *x* rheostat resistance between the input and the cursor will be:



$$Re = \frac{(Rr-x)\,(Rp+x)}{Rr+Rp} = -\frac{1}{Rr+Rp}\,x^2 + \frac{Rr-Rp}{Rr+Rp}x + \frac{RrRp}{Rr+Rp}$$

In our case the rheostat value is *Rr* = 27 Ω, and the parallel resistance is *Rp* = 11 Ω:

$$Re = -\frac{x^2}{38} + \frac{16\,x}{38} + \frac{297}{38}$$

The x value is related to the turning angle ϕ from 0 to Φ (270° for my rheostat):

$$x = Rr\frac{\varphi}{\Phi} = 27\frac{\varphi}{270} = 0.1\varphi$$

Therefore: $Re = -\frac{x^2}{38} + \frac{16\,x}{38} + \frac{297}{38} = \frac{1}{38}\,(-0.01\,\varphi^2 + 1.6\varphi + 297)$, for Rp = 11 Ω

In general, for my rheostat: $Re = -\frac{0.01}{27+Rp}\,\varphi^2 + 0.1\frac{27-Rp}{27+Rp}\varphi + \frac{27Rp}{27+Rp}$

where can be easily installed Rp = 22 Ω, 11 Ω, or 7.33 Ω, up to tree 22 Ω resistors in parallel.

$Re = -\frac{x^2}{49} + \frac{5\,x}{49} + \frac{594}{49} = \frac{1}{49}\,(-0.01\,\varphi^2 + 0.5\varphi + 594)$, for Rp = 22 Ω

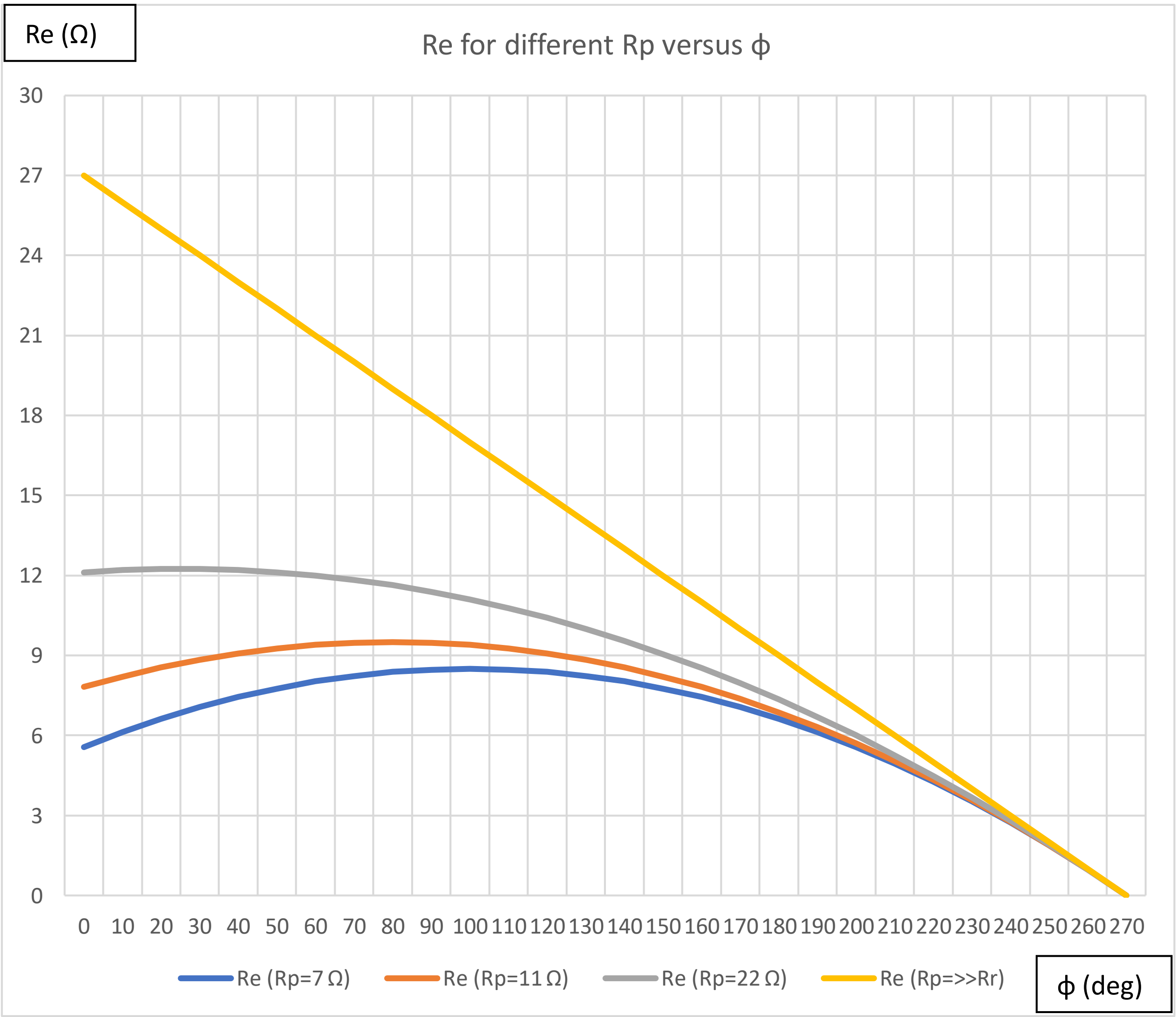
or $Re = -\frac{x^2}{34} + \frac{20\,x}{34} + \frac{297}{34} = \frac{1}{34}\,(-0.01\,\varphi^2 + 2\varphi + 189)$, for Rp = 7 Ω

Of course, for Rp extremely big compared to the rheostat value, the limit of the expression is:

$Re = 27 - 0.1\varphi$, maximum at the beginning and zero at the end.

Bad (left) and replacement (right) rheostat photos are below:

A graphical comparison of previous scenarios is illustrated in the next figure.



I have selected the Rp = 11 Ω because the maximum value is 9.5 Ω, a common value for the 1920's, and also because when turning on and off the current is not too big, nor to low, and it is easy to see the tubes glowing. Like for other values, in the useful range (less than 6 Ω) the variation is quite linear with ϕ and around 10° is added to the potentiometer variation stroke.

17. December 5, 2024: first long-range reception with the indoor loop antenna 1050 kHz (40 %) a New York station, ESPN. A distance in straight line of 331 miles = 533 Km. next morning and next night the station was tuned once gain.

18. The beautiful radio under test in my room: powered by ARBEIII – Universal Battery Eliminator and connected to an haute impedance speaker. On back ground some other items of my collection.

I hope that this paper will help interested vintage restorers in their work on the 1920's radios.

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VA2OBW, SQCRA member

Montreal, December 12, 2024.